Wisconsin Forest Tree Improvement Program
2005 Annual Report

Prepared by

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Introduction

The Wisconsin Department of Natural Resources' (WDNR) forest nursery program produced and distributed 14.6 million tree seedlings in 2005, reforesting almost 18,000 acres of public and private lands in Wisconsin. The use of genetically improved seed remains a critical part of this annual reforestation effort, ensuring that WDNR seedlings are well-adapted to Wisconsin growing conditions and have a high potential for survival and growth. The Wisconsin tree improvement program, through the long-term support of the state nurseries, continues to develop and manage seed orchards using a combination of parent tree and family selection, progeny testing, and selective breeding. First generation seed orchards are currently established for white pine, jack pine, red pine, white spruce, red oak, and black walnut. Second-generation seed orchards are established for jack pine.

Seed orchards are the primary mechanism used to produce genetically improved seed in quantities large enough to support nursery production. We continue to expand and develop our seed orchards for white pine, jack pine, red pine, white spruce, red oak, and black walnut (Table 1). Priorities for 2005 included completing controlled pollinations within four populations of advanced generation jack pine, selection of superior parent trees for establishment of second generation red pine progeny tests and seed orchards, and development of grafted or clonal populations of white spruce, black walnut, and red oak. Our work continues to emphasize critical maintenance and intensive management of seed orchards to facilitate the production of greater quantities of improved seed. This includes research on improved seed production and collection techniques for traditionally challenging species such as red pine.

Table 1. WDNR seed orchard acreage by species.

Species	Acreage
Jack Pine	20
Red Pine	45
White Pine	52
White Spruce	34
Black Walnut	13
Red Oak	12

This report highlights the 2005 program activities and accomplishments for our primary tree improvement species. Please feel free to contact the report's authors if you have any questions or comments.

2005 Program Highlights

Jack Pine

Selection and breeding for a third generation continued in four populations of jack pine growing at the Ten Mile Creek Seed Orchard (Wood Co.). Height measurements from the fall of 2001, in conjunction with scores for incidence of pine-oak gall rust (*Cronartium quercuum*), were used to select superior trees for breeding using a polycross mating scheme to produce progeny for third generation populations. A total of 806 controlled pollinations were completed in the spring of 2005, focusing on trees that did not produce flowers for crosses in 2004. One hundred and ninety-two single-pair crosses among the best trees in elite families were also made to use in developing production seed orchards. First-year cone counts indicate that all families have successful crosses. The overall success rate appears to be better than previous years and this should complete the third generation breeding efforts within the four Ten Mile Creek 'index' populations. The 2004 controlled crosses were harvested in September 2005; these crosses produced only 55 cones out of 272 pollinated flowers. A rainy spring and cooler than average summer may have contributed to the poor cone set. In addition, many of the successful cones were heavily damaged by insects. Seeds will be extracted from these cones during the winter.

A planting site for the third generation index populations was identified on the Black River State Forest. Planting should take place in the spring of 2007. The Ten Mile Creek populations will be thinned in 2006 to develop a production seed orchard. Breeding efforts will shift to the Ladysmith (Rusk County) 2nd generation breeding population that is currently managed by Plum Creek Timber Company. Superior trees have been selected and breeding will start in the spring of 2006. Finally, the Greenwood second generation seed orchard (Waushara County) was rogued to remove trees with poor form and/or high incidence of pine-oak gall rust.

Eastern White Pine

Information on the extent and patterning of genetic variation in Wisconsin's eastern white pine populations will be obtained from the two provenance/family tests established during 2002-2003. Following genetic evaluation, these tests will also provide a source of improved seed for the state nurseries. Cones from 234 trees representing 50 natural stands of eastern white pine were collected across Wisconsin during 1996-2000. In addition, Dr. Richard Meier (USDA-Forest Service, R-9) provided seed from 142 USDA-Forest Service selections made in the Upper Peninsula of Michigan, Minnesota, and Wisconsin. The first orchard was field planted in 2002 on a 14-acre site near Lake Tomahawk in the Northern Highland-American Legion State Forest to create a "northern" Wisconsin test. A "southern" Wisconsin orchard was field planted in 2003 on the Black River State Forest.

A summer drought caused considerable moisture stress at both sites. Fortunately, few trees died; however, growth was reduced, especially at the Lake Tomahawk site. Both plantings were maintained by mowing through the growing season and bud caps were attached to all trees in the late fall to

discourage deer browsing. The short-term benefit of this research will be the identification of eastern white pine seed sources appropriate for use in reforestation efforts; the long-term benefits will be the development of two seedling seed orchards for future seed production and genetic resource conservation of Lake States white pine.

The Black River State Forest family test was measured for height and survival during the fall of 2005, so data for each progeny test collected at the end of the third growing season was examined for preliminary patterns of performance (Figure 1). Although exact comparisons between the two sites are not possible given their different ages, we can already see that some families are performing better at Lake Tomahawk while others are performing better at Black River Falls. Analysis to relate performance at each site to the geographic origin of families continues.

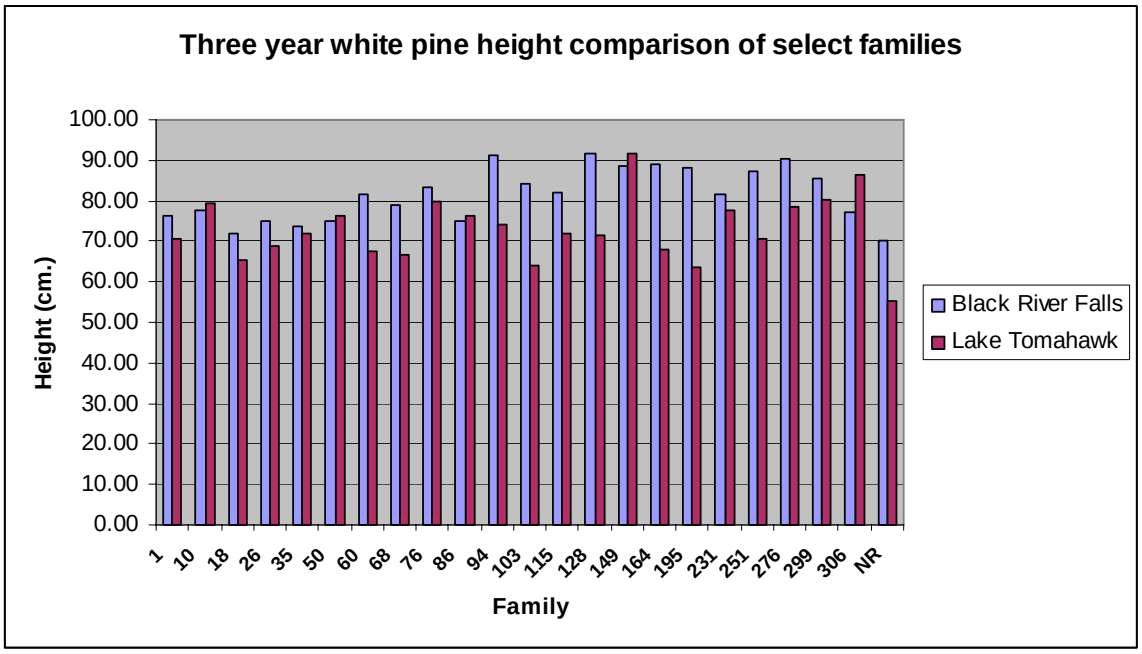

Figure 1. Third-year height comparison for 22 select families and 2 'nursery run' plots at the Black River Falls and Lake Tomahawk white pine sites.

Beginning in 1983, through a cooperative effort with the U.S. Forest Service, grafts of putative blister rust-resistant eastern white pine were obtained and planted to develop a ten-acre clonal seed orchard at the Sawyer Creek Fishery Area (Washburn County). Between 1994 and 2003, open pollinated progeny from these clones were planted in nearby fields and monitored for height growth and blister rust incidence by Mr. Shane Weber, WDNR Northern Region Plant Pest and Disease Specialist. Early test results indicate that clone #10 performed significantly worse than all other clones, so ramets of this clone were essentially eliminated from the seed orchard (Figure 2). Over the next few years, we will be adding new clones to the orchard using materials from a new rust screening program the Forest Service is implementing at the Oconto River Seed Orchard.

Figure 2. David Stevens and Kristin Peterson removing poor performing trees at the Sawyer Creek white pine seed orchard in Washburn County.

Red Pine

Three 15-acre seedling seed orchards consisting of 310 families from native Wisconsin stands were established in 1970 at Avoca (Iowa Co.), Lake Tomahawk (Oneida Co.), and Ten Mile Creek (Wood Co.). These seed orchards have been thinned twice using height data to retain the tallest families and best-formed trees.

The 'best' individuals from within the tallest 125 families at each orchard were identified during 2003-04 using diameter measurements (in lieu of height – the trees are now 60+ feet tall) and stem form ratings. Identified trees were surveyed for cones at all three orchards. Cone production was extremely poor and open-pollinated seed was only collected from 20 trees at the Lake Tomahawk orchard. Seed will be collected from the remaining selections in 2006 and used to establish progeny tests and a second generation seed orchard.

The Lake Tomahawk orchard was commercially thinned in the late fall of 2005 to improve crown development for increased seed production and to facilitate seed collection efforts. The Avoca orchard has been marked and should be

commercially thinned in 2006. The Ten Mile Creek orchard was commercially thinned in 2004.

White Spruce

White spruce tree improvement efforts continue to focus on the intensive management of seed orchards and progeny tests in order to supply improved seed for all state nursery production. State funding was also secured to build an improved greenhouse and propagation facility at the WDNR South Central Regional Headquarters in Fitchburg. This facility will greatly improve our ability to develop second generation grafted/clonal seed orchards. Greenhouse plans were developed this summer and construction should begin in 2006.

Seventeen-year height and diameter measurements for the Sawyer Creek progeny test (Washburn Co.), a 10-acre plantation established in 1989, were taken in 2003 and analyzed and ranked according to tree volume. This test contains selected materials from 168 different families throughout the Lake States region and the Ottawa Valley of Ontario, Canada. Superior parents identified in this analysis will be incorporated into the grafting program to expand clonal seed orchards. The orchard will be marked and thinned in 2006 to improve crown development for increased seed production and to facilitate seed collection efforts.

The 6-acre Lake Tomahawk seedling seed orchard, established in 1969 in the Northern Highland-American Legion State Forest, was heavily defoliated by spruce budworm during 2004. Due to this defoliation, no cones were produced in 2005 and the overall health of the trees declined. The site was aerial sprayed with Bt (*Bacillus thuringiensis)* and Asana™ during the spring of 2005. The first treatment with Bt reduced budworm populations by about fifty percent, while the second treatment with Asana™ killed most of the remaining insects.

The 6-acre Mead Wildlife Area (Marathon County) seedling seed orchard is comprised of 175 families representing materials from the Ottawa Valley and selections from the Lake States region made by the USDA Forest Service. The shortest 30% of this population was marked for thinning in 2004 based on 1997 height data. The thinning will allow greater access into the orchard for future cone harvests as well as improve crown development. The orchard should be commercially thinned in 2006.

Black Walnut

In order to accelerate the genetic improvement and conservation of black walnut, a pilot project was initiated to identify potential "seed production areas" within natural stands in southern Wisconsin. Seed production areas are natural stands of high quality trees that are managed for seed collection purposes. Seed production areas could provide an immediate supply of high quality seed to the state nurseries. In addition, progeny testing of these sources, along with culling of poor individuals and stands, would provide a modest level of genetic improvement. Since most of the seed production areas will likely be located on private land, the key to success will be cooperation with

private landowners. Incentives, such as increased nut prices, will be needed to encourage landowner participation. WDNR field foresters throughout the southern part of the state were contacted over the winter of 2005 to help identify candidate sites. During the summer and fall of 2005, many of these sites were evaluated for suitability as seed production areas.

Red Oak

Using a similar strategy, potential northern red oak seed production areas were identified on state and county lands during 2005. A network of seed production areas could provide an immediate and reliable source of quality native seed in several areas across the state, improving the consistency and diversity of the state nursery acorn supply.

Ninety-three grafted red oak seedlings originating from superior Wisconsin trees were planted in the orchard at Bell Center (Crawford County). These clones will be used for future seed production and genetic resource conservation of northern red oak. A 7.5 foot temporary deer fence was erected around the orchard to eliminate deer browse (Figure 3).

Figure 3. Plastic deer fencing erected around the Bell Center hardwood seed orchard in Crawford County.

Reforestation Issues

Reforestation and Invasive Species Monitoring Program

We often focus on implementing forestry practices (like planting more trees!) and spend less time on monitoring and improving the outcome of those practices. For example, Wisconsin landowners plant 20-30 million tree seedlings and spend an estimated $10 million annually on reforestation practices. Despite this large investment in time and money, comparatively small efforts are made to ensure planting success. That is why the state nursery program will be implementing a new reforestation monitoring program in 2006. Each year, a portion of reforestation plantings on private, industrial,

state, and county lands will be surveyed for stocking levels, survival, growth, weed competition, planting technique, and insects and diseases. Data will be collected and analyzed to determine the reasons for regeneration success or failure. In addition, this monitoring will provide valuable statewide information on the presence and distribution of invasive exotic species on reforested lands. By monitoring tree plantings each year, we will be able to look at long-term trends, detect problems early, and improve reforestation methods.

Seedling Temperature Data Loggers - Year 2

Bare root seedlings must be kept cool from the time of lifting until final planting in order to reduce moisture stress and maintain dormancy. Last year, we told you about a new technology that was helping the state nurseries monitor seedling temperatures. Temperature data loggers - stainless steel encased computer chips that can be programmed to record the temperature at selected time intervals - were placed in tree shipments this spring to monitor seedling

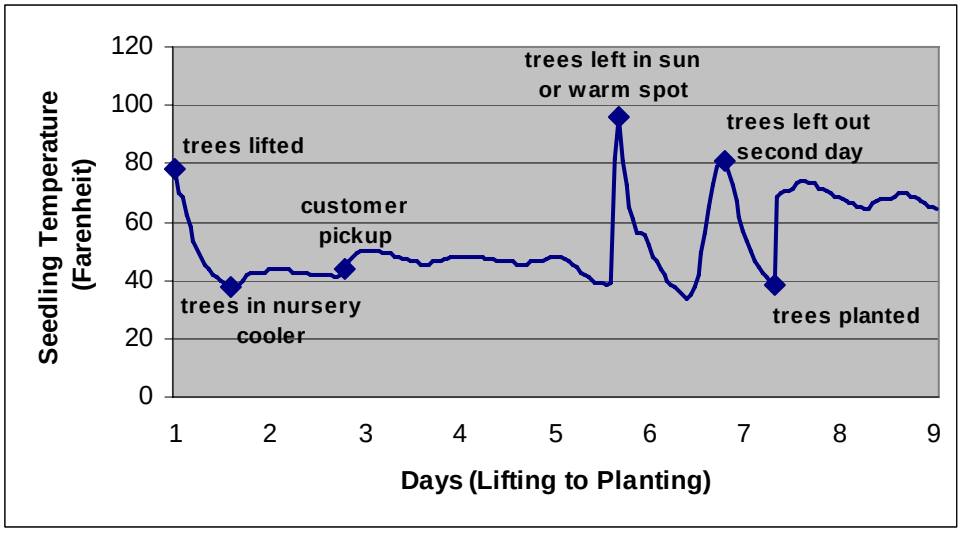

Figure 4. Red oak tree order from spring 2005. Example of poorly handled stock. Mid-day temperature spikes during two days before planting indicate that the trees were left in the sun or other warm location.

temperatures during storage and transportation. Figure 4 follows the temperature within one shipment of trees over 9 days, from nursery to planting site. Data from these devices have been valuable for monitoring the quality of shipping and storage conditions. We need to do a better job of educating landowners and contractors alike regarding the impact of placing shipments in unsuitable storage prior to planting (e.g., days number 6-7 of Figure 4.)

Summary of 2005 Program Activities

Jack Pine

- Completed 806 controlled pollinations at Ten Mile Creek second generation index populations. Focused on trees that did not produce flowers in 2004 as well as selected single pair crosses.
- Harvested 55 cones from the 2004 controlled crosses at Ten Mile second generation index populations.
- Removed 411 trees from the Greenwood second generation seed orchard (Waushara County) due to poor form and/or high incidence of pine-oak gall rust. Mowed and remapped orchard.
- Identified, cleared, and roller chopped site for third generation index populations on the Black River State Forest.
- Selected trees for spring 2006 breeding at the Ladysmith (Rusk County) 2nd generation breeding population.
- Completed pedigree database.
- Marked Ten Mile Creek index populations for thinning.
- Marked Bean Brook breeding population for thinning.

White Pine

- Maintained 14-acre family test at the Lake Tomahawk seed orchard and 10-acre family test on the Black River State Forest. The family test represents 256 white pine selections from Wisconsin, Minnesota, and the Upper Peninsula of Michigan.
  - Maintenance activities included removal of 2004 bud caps and application of 2005 bud caps. Each site was mowed to reduce grass competition and rodent damage .
  - Three-year height measurements and survival were taken at the Black River Falls planting. Data analyzed to identify family differences and compared with 3-year data at the Lake Tomahawk planting .
- Poor performing trees removed from the Sawyer Creek blister rust resistant clonal seed orchard. Mowed orchard.

Red Pine

- Collected cones from 20 superior trees at the Lake Tomahawk seed orchard for use in establishing second generation seed orchards. Extracted seed from these collections.
- Lake Tomahawk seed orchard commercially thinned.

White Spruce

- Sprayed 6-acre Lake Tomahawk seedling seed orchard with Bt (*Bacillus thuringiensis)* and Asana™ pesticide to control spruce budworm outbreak.
- Completed pedigree database.

Red Oak and Black Walnut

- Planted 2004 grafts into larger containers.
- Out-planted 93 red oak grafts in new clonal orchard site at Bell Center
- Constructed deer fence around entire planting to prevent deer damage.
- Mowed red oak grafts at Deansville Wildlife Area and Bell Center seed orchards.
- Controlled weed competition around grafts at Bell Center.
- Identified and evaluated potential seed collection areas around state for red oak and black walnut.

Miscellaneous

- Conducted reforestation survey of DNR foresters. Information will be used in developing monitoring program protocols.